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20010330 116

Mission

"The Dynamic Avionics Measurement Branch at the NAWC-AD conducts developmental test and evaluation (DT&E) of Navy aircraft and their avionics systems. These systems include radars (fighter/attack, sea surveillance, and AEW), Navigation (IFF, GPS, and INS), communications (voice and data link), reconnaissance systems, antenna systems, forward looking infrared systems and ASW systems. Also included are electronic support measures (ESM) systems, electronic intelligence (ELINT) systems, radar warning receivers, missile warning systems, communications receivers, and antenna patterns. Additionally, NAWC-AD has the mission to conduct performance testing of ECM and ECCM avionics systems including aircraft signature measurements (RCS), radar and communication Jammer-to-Signal (J/S) ratio measurements, Chaff and decoy measurements."

Mission.ppt

Dynamic Measurement Capabilities

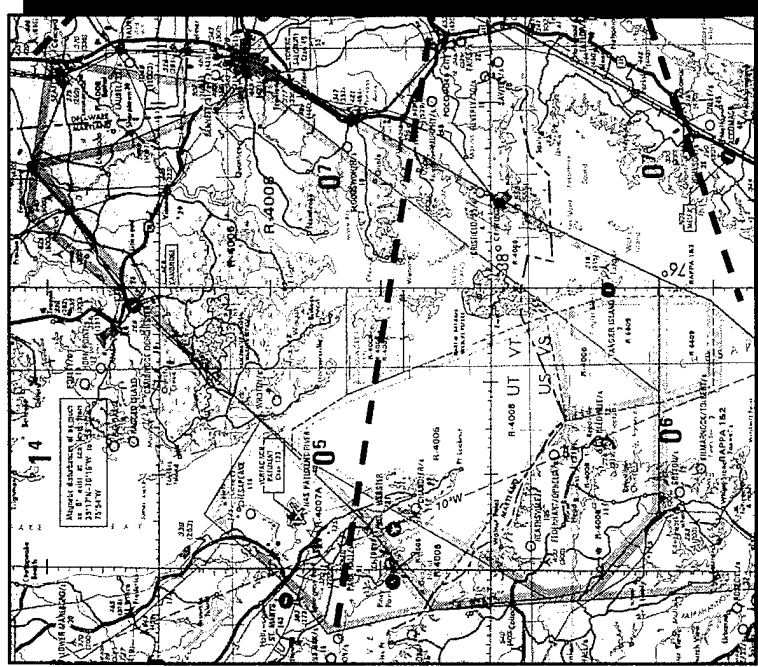|	Avionics	Electronic Warfare (EW)	Radar Cross Section (RCS)
Measurement Capabilities	Antenna Pattern Navigation Reconnaissance Radar Navigation Communication Reconnaissance Antenna Patterns	ESM (Airborne Receiver Performance) Jammer Techniques Receiver Sensitivity Jammer Duty Cycle Threat Warning Direction of Arrival Accuracy	Whole Body & Doppler Signature Measurements Down Range & ISAR Measurements Jammer-to-Signal Ratio Chaff & Decoy Measurement

Flight Test Systems	Real-Time Telemetry Link
	
	Real-Time Avionics Workstation
		Automated Emitter Simulation
		  Local Site
		  Remote Site
		  Mobile Assets
		
		Radar and Communication Simulation
		
		Automated Control
			Advanced Dynamic Aircraft Measurement System (ADAMS)
			
			Waveform Data Processing System (WDPS)
			
			Real-Time RCS Engineering Workstation
			
			Dynamic Flight Programming & Control
			
			Signature Data Library

ATR RCS Cap2.ppt

Infrastructure

❖ **Flight Test Area**

  – **Chesapeake Ranges**

  – **Offshore Ranges**

❖ **Range Control Center**

❖ **Range Instrumentation Tracking Systems**

  – **Time Space Position Information (TSPI)**
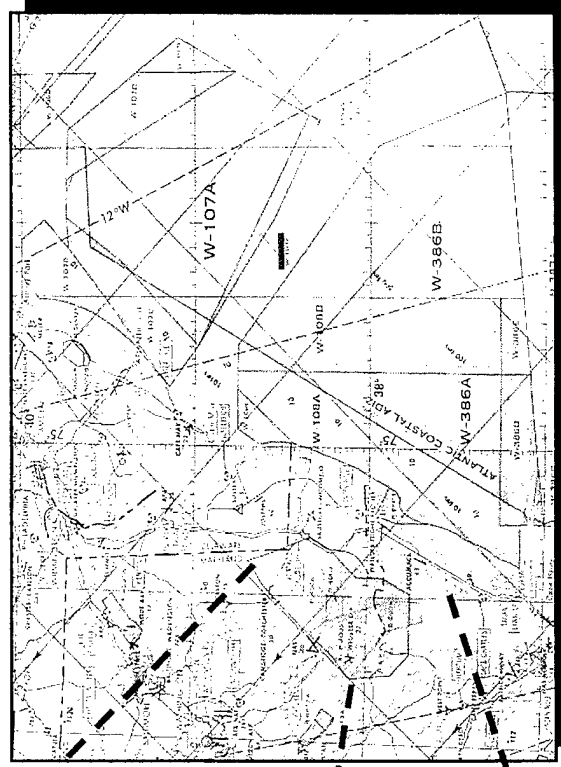
❖ **Real-Time Telemetry Processing System**

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ATR RCS Cap1.ppt

Flight Test Areas
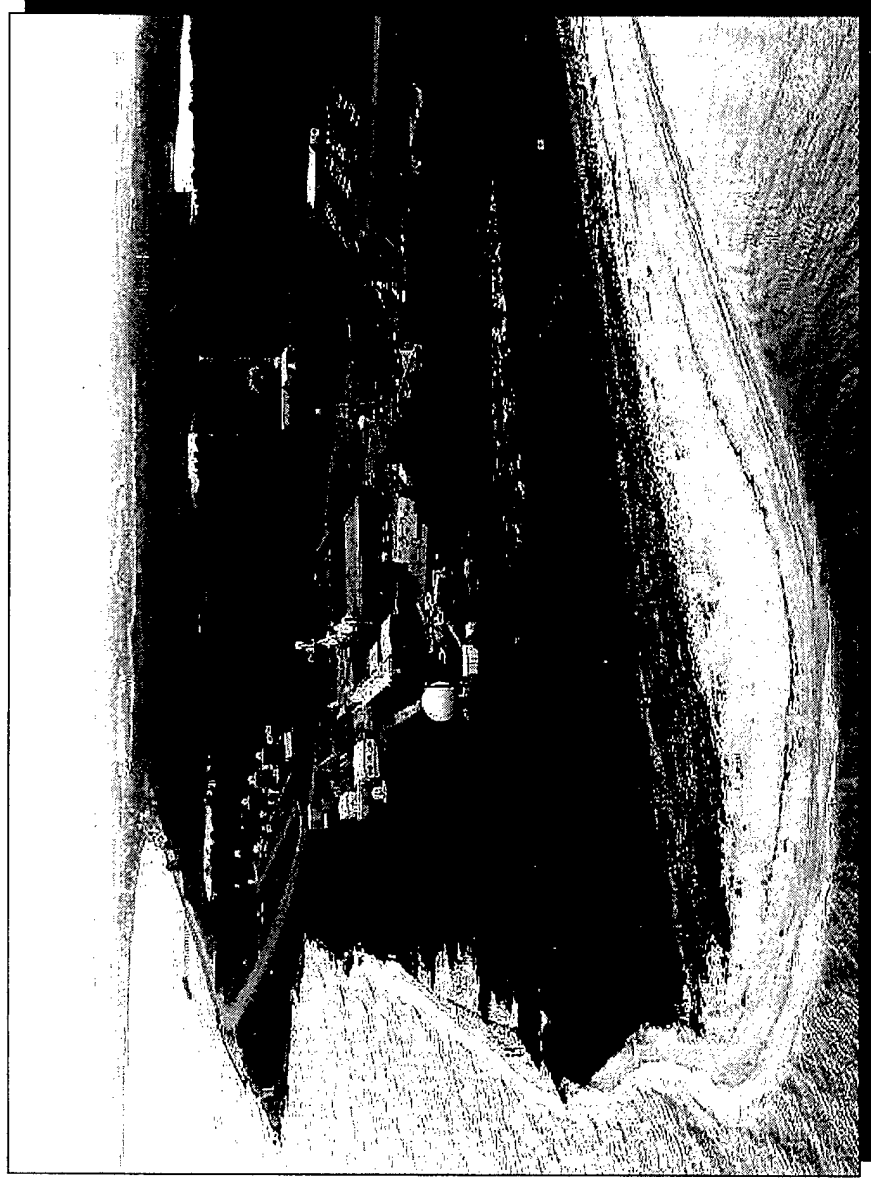
Controlled Flight Environment

Offshore Ranges
Warning Areas W-107/8/386
Approx. 18,000 square miles
Surface to unlimited altitude

Over Water Supersonic Areas
Drop Areas

Chesapeake Ranges
Restricted Areas R-4002/5/6/7/8
2,400 square miles
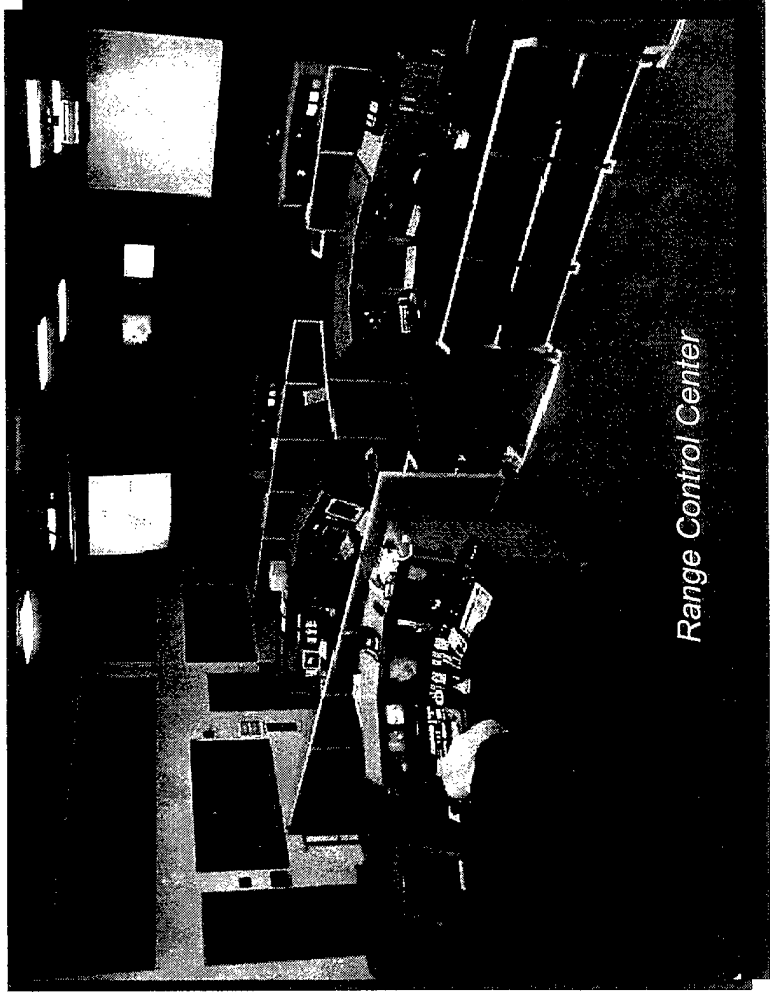**Surface to 80,000 feet**

Cedar Point Facility

Range Control Center

❖ **Real-Time Control, Safety, Data Acquisition and Processing of Multiple Test Vehicles (up to 128)**

❖ **Simultaneous Mission Support (5 Mission Control Consoles)**

❖ **Range Safety (Airspace & Surface)**
  – Local and Remote Area Surveillance (IFF, FACSFAC VACAPES, Link-11, Surface Radar)

❖ **Communications Diversity (Video, Voice and Data)**
  – Radio, Microwave, Land-line, Fiber Optics, SATCOM
  – Secure Operations
  – DIS/DSI Compatibility With External Connectivity

❖ **Multisensor Integration**
  – Time Space Position Information (TSPI)
  – Video (High Resolution)
  – Film (5 to 400 Frames Per Second)
  – Audio
  – Meteorological Data

Range Control Center

Range Cntl Cnt.ppt

Tracking Instrumentation Diversity

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❖ **Radar**
- Single and Multiple Object
- Cooperative and Noncooperative
- Frequency and Geographic Diversity

❖ **Electro-Optical**
- Video and Film Theodolites
- Automatic Laser Tracking System (ALTS)
- Infrared (IR)

❖ **Multilateration Tracking System**
- Mid-Atlantic Tracking System (MATS)
- Global Positioning System (GPS)
  - Large area coverage
  - Multiple participants
  - Over the horizon
  - Land, air and sea coverage

❖ **Area Surveillance**
- IFF
- FACSFAC
- Link II
- Surface

Multilateration (MATS/GPS)

Optical
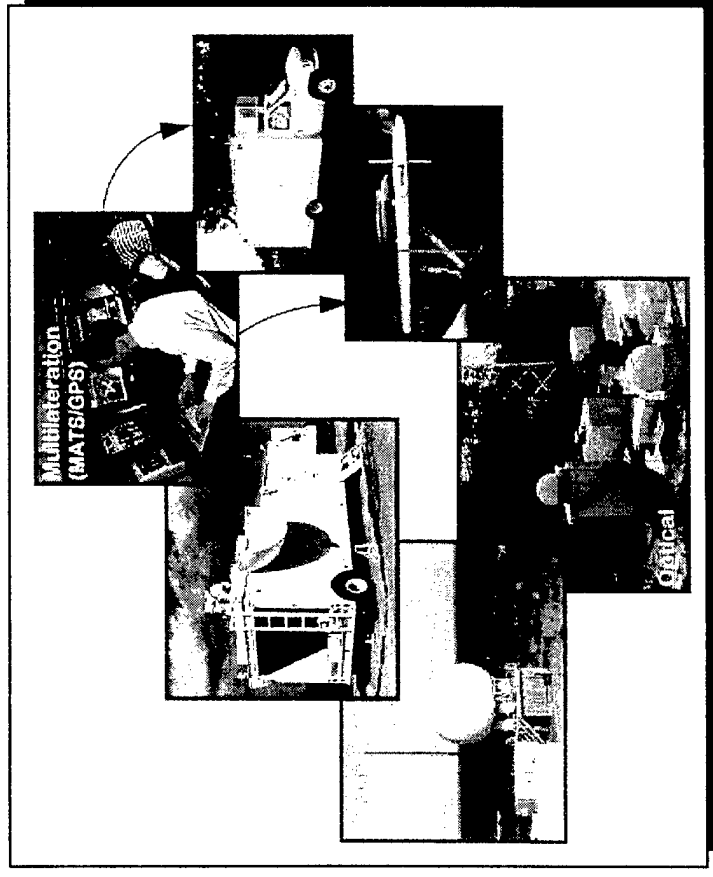
Range Tracking Systems Performance

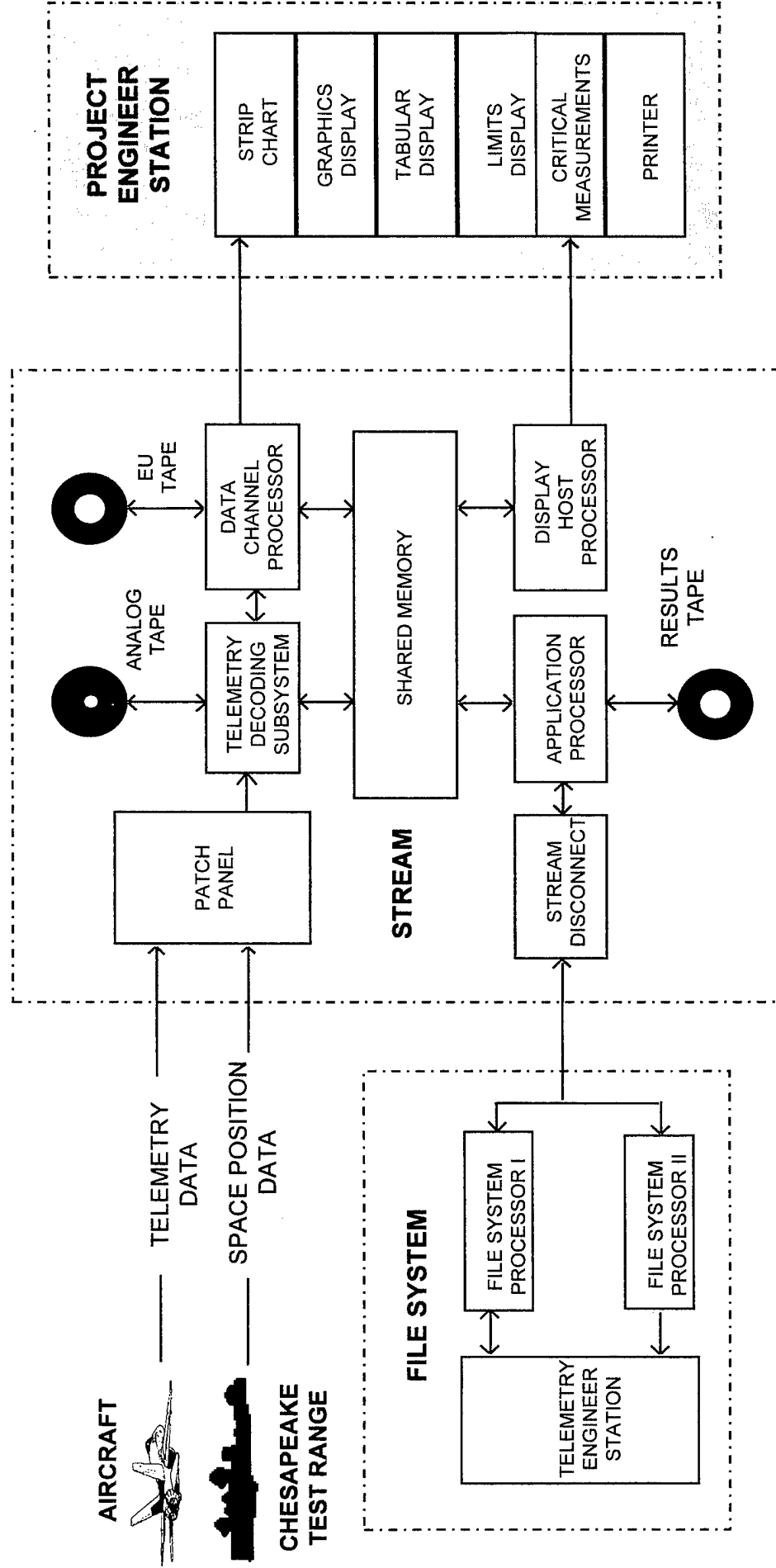| Tracking System	Tracking Range	Accuracy (RMS)		Special Considerations
ALTS (portable) Automatic Laser Tracking System (2)	8.5 Miles	Range: 3 feet Angle: 0.1 mils		Requires retroreflector on target
THEODOLITE Range * w/Laser Ranger **	15 Miles (max)	@ Hooper Target (4 miles) X,Y,Z: 15 feet (Real-time) X,Y,Z: 3 feet (Post-flight film reading)		Visual observation Man in the Loop 4 Fixed Contraves 1 Mobile Contraves
CEDAR POINT RIR-778 Radars (3)	Skin 100 Miles Beacon 200 Miles	Range: 10 feet Angle: 0.1 mils		Nth time around trackers 3 Radars
CEDAR POINT AN/FPQ-17 Radar (MIR)	Skin 100 Miles Beacon 200 Miles	Range: 10 feet Angle: 0.25 mils		16 tracks Skin 2 tracks Beacon
WALLOPS RADARS FPS-16, FPQ-6	200 Miles	Range: 6 feet Angle: 0.1 mils		3 Radars linked into ATR
GPS with High Dynamic Instrumentation Set (HDIS) 15 External Pods 5 Internal Advanced Range Data System (ARDS) plates	600 miles w/ relays or Line of Sight	X&Y: 6 feet Z: 10 feet X&Y: 21 feet Z: 35 feet X&Y: 19 feet Z: 32 feet X&Y: 42 feet Z: 70 feet	Pitch β 0.3 Roll β 0.5 Heading β 0.3 H. Position τ 4.0 V. Position τ 6.0 H. Velocity f 0.7 V. Velocity f 0.7	P/Y-Code Differential P-Code Absolute C/A-Code Differential C/A-Code Absolute

* Requires three sites for solution

** Single Mobile Theodolite has real-time accuracy

β - degrees τ - feet f - ft/sec

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Real-Time Telemetry Processing System (RTPS)

Dynamic Collection Flight Control

❖ **Computer-Generated Flight Profiles**

❖ **Pre-Fly RCS Maneuvers**
   - Maximizes Data Collection
   - Minimizes Flight Time
   - Employs Manned Flight Simulator at ACETEF

❖ **Real-Time Data Bin Filling Routine**

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Aircraft Aspect and BIN Filling Display

Look Angle →

← Depression Angle
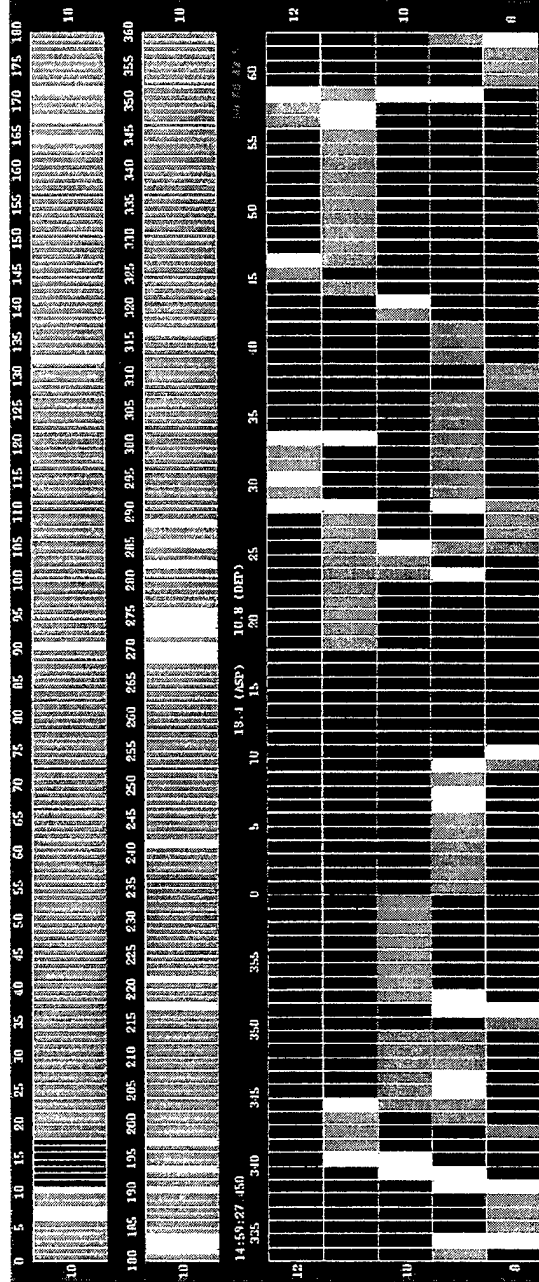
Dynamic In-Flight Radar Cross Section Measurements

❖ Whole Body & Doppler Signature Measurements

❖ Down Range & ISAR Measurements

❖ Jammer-to-Signal Ratio

❖ Chaff & Decoy Measurement

Dynamic RCS Measurement System

Air Vehicle RCS Measurement Process

RATSCAT/RAMS,
Holloman AFB

Atlantic Test Range,
NAWCAD, Patuxent River

Junction Ranch,
NAWCWD, China Lake

Radar Reflective Lab,
NAWCWD, Pt. Mugu

Various DoD Labs

Outdoor Dynamic

Static Outdoor

Compact Ranges
Indoor Anechoic Facilities

Modeling & Simulation

Advanced Indoor Range,
Wright Labs

Av RCS Msmt.ppt
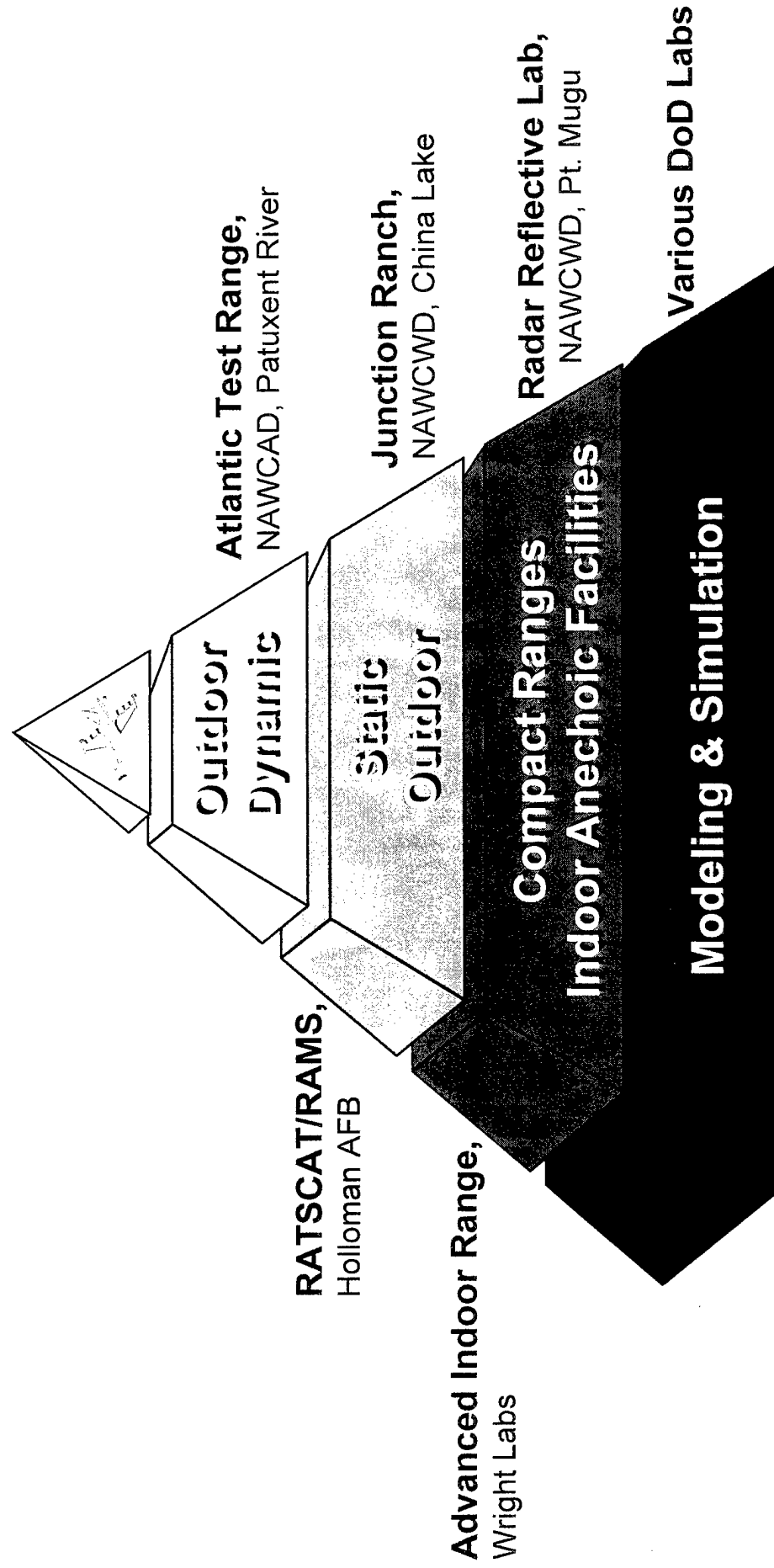
Signature Measurements Support DoD Acquisition Process

❖ **Signature Measurements Required for Vehicle & Munitions Development**

❖ **Different Vehicles & Different Environments (Land, Air, Sea, Space)**

❖ **Different Types of Measurement Facilities Support the "Cradle-to-Grave" Acquisition Life Cycle**

- **Indoor Static Tests (Compact Ranges, Wind Tunnels)**
  - Component, Subassembly, Scale Model
  - Controlled Environment
  - Precision Measurements

- **Outdoor Static Tests**
  - Full Size Aircraft, Ground Vehicle, Ship, Weapon Models
  - Precision Measurements

- **Outdoor Dynamic Tests (Free Flight)**
  - "Real" Targets
  - Vibration, Flexing, Doppler Modulation, Chaff, J/S

Concept Definition

Dem-Val

EMD

Production

Deployment

Increased Test Cost
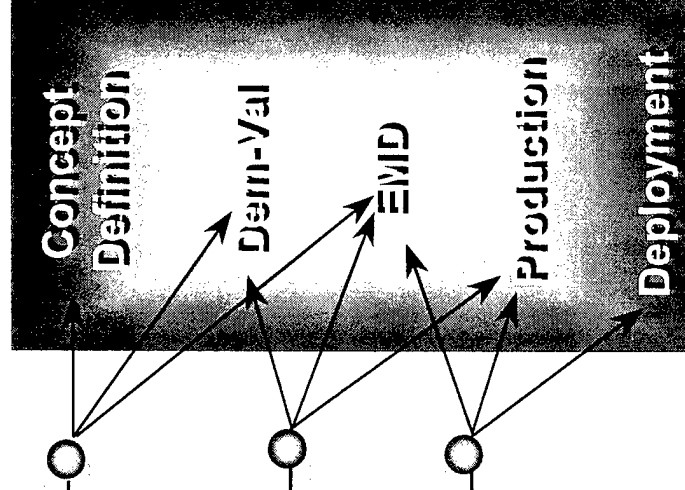
Why Dynamic In-Flight RCS Measurements?

❖ **Full-Size Actual Test Article**

❖ **Target Scintillation**

   – Engine Modulation

   – Propeller Modulation

   – Antenna Rotation

   – Vehicle Vibration

   – Vehicle Flexing

❖ **Towed / Expendable Decoys**

❖ **Jammer-to-Signal**

❖ **Chaff**

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Dyn RCS Msmt 2.ppt

Dynamic RCS Measurement Features

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❖ **80 Simultaneous Measurements**

    – **150 MHz to 35 GHz**

    – **500 Hz to 200 kHz Pulse Sampling Rate**

    – **Vertical & Horizontal Polarization**

    – **+1.1/-1.5 dB (NIST Report NISTR 5073 of Feb 98)**

    – **1 Degree Aspect Resolution in both AZ & EL**

❖ **Coherent and Non-Coherent Measurement Systems (ADAMS & WDPS)**

❖ **Real-Time Processing & Display of Polar Plots**

❖ **Complete Statistical Reports Including Probability Density Function (PDF)**
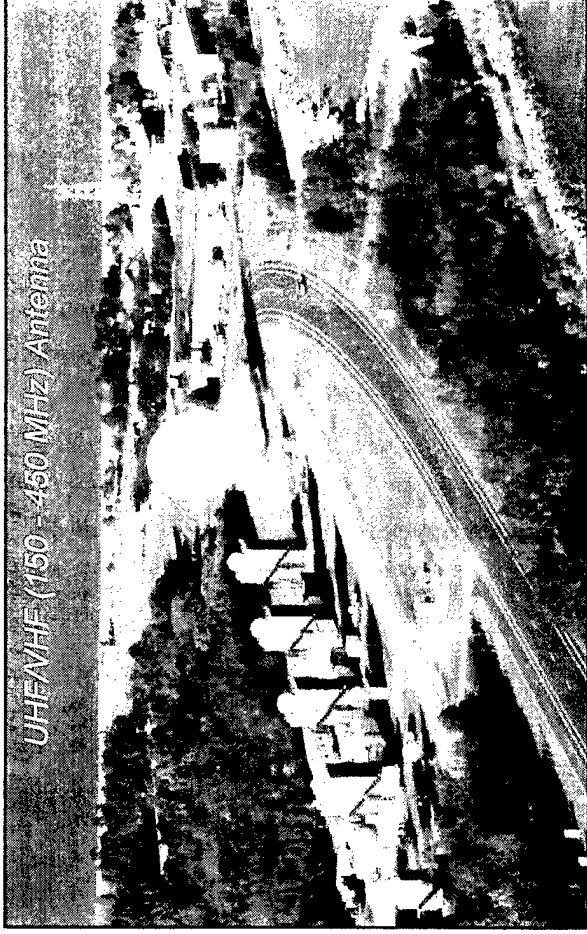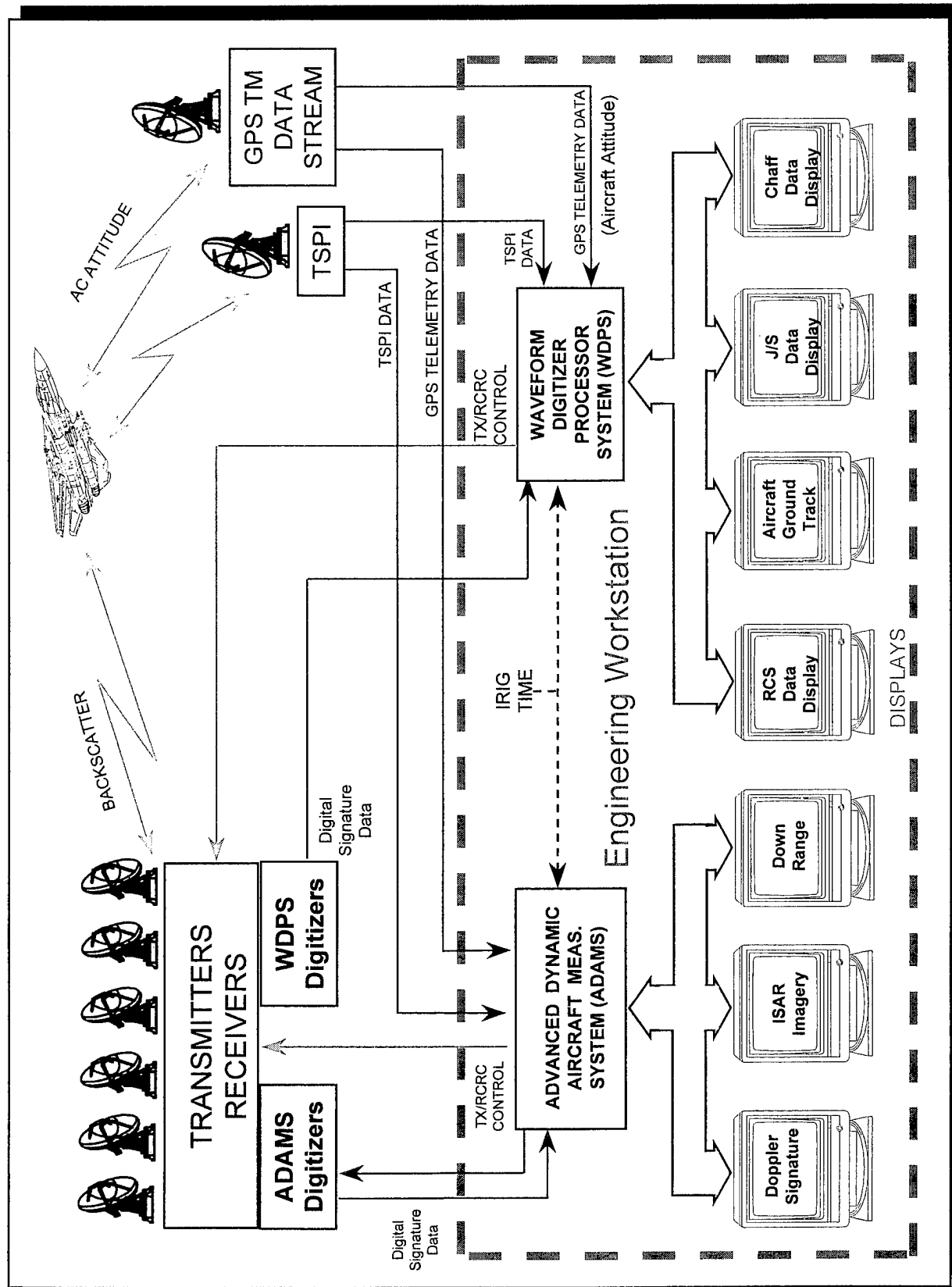
❖ **Dynamic Flight Control**

Dyn RCS Msmt 3.ppt

RCS Measurement Antenna Sites

UHF/VHF (150 - 450 MHz) Antenna

0.7 - 35 GHz Antennas

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RCS Flight Test System

Real-Time RCS Flight Test System

RCS Engineering Workstation

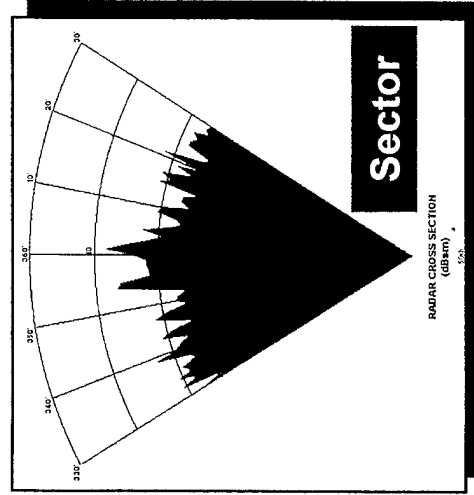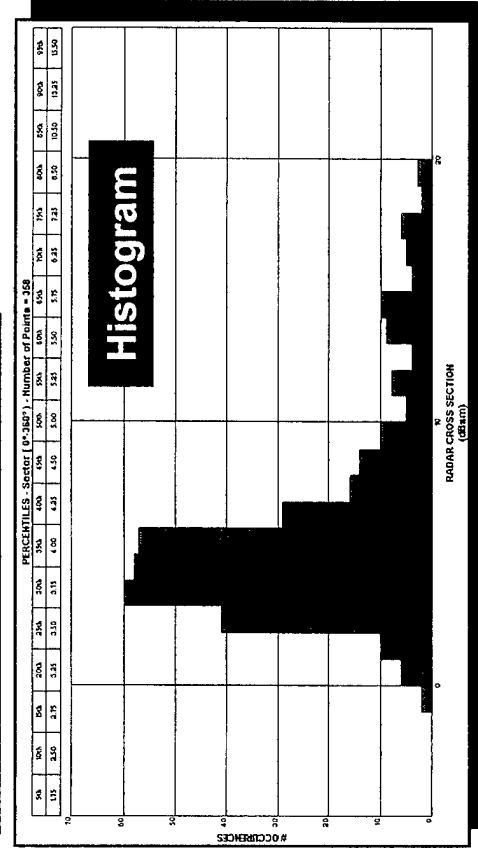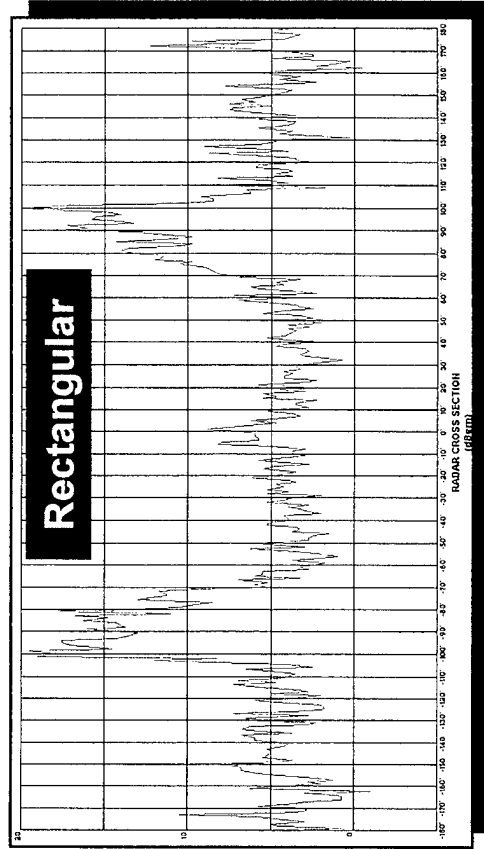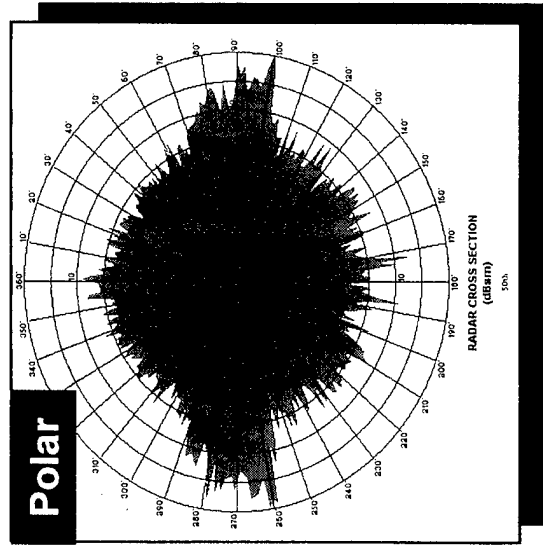NAVAL AIR WARFARE CENTER
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Dynamic Signature Capabilities

❖ **Whole Body RCS Signature Measurements**

❖ **Doppler Signature Measurements**
- Blades
- Jet Engine Modulation (JEM)

❖ **Precision Down Range Profiles**

❖ **ISAR Imagery**

❖ **Jammer-to-Signal Ratio Measurements**

❖ **Chaff Measurements**
- Growth Rate (SP)
- RF Spectrum
- Shadow Graph

❖ **Decoy Measurements (Towed and Expendable)**

❖ **Extensive Signature Data Library**

Dyn Signature.ppt

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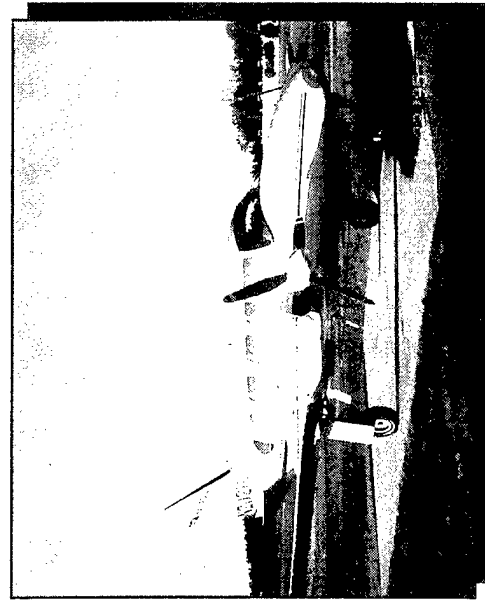Aircraft Division
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Whole Body RCS Signature Measurements
Sample Data Products

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Rectangular

Sector

Polar

Histogram

Doppler Signature Measurements
Sample Data Product - Blade Modulation

Example: Piper Navajo

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Prop Modulation

Skin Line

Left Broadside

Nose

Right Broadside

Tail

Aircraft Aspect

fc= 10.2765 GHz
PRF= 16 KHz
P.W.= 1.2 m sec
Pol= HH

UP

8KHz

0

-8KHz

Down

Doppler Frequency
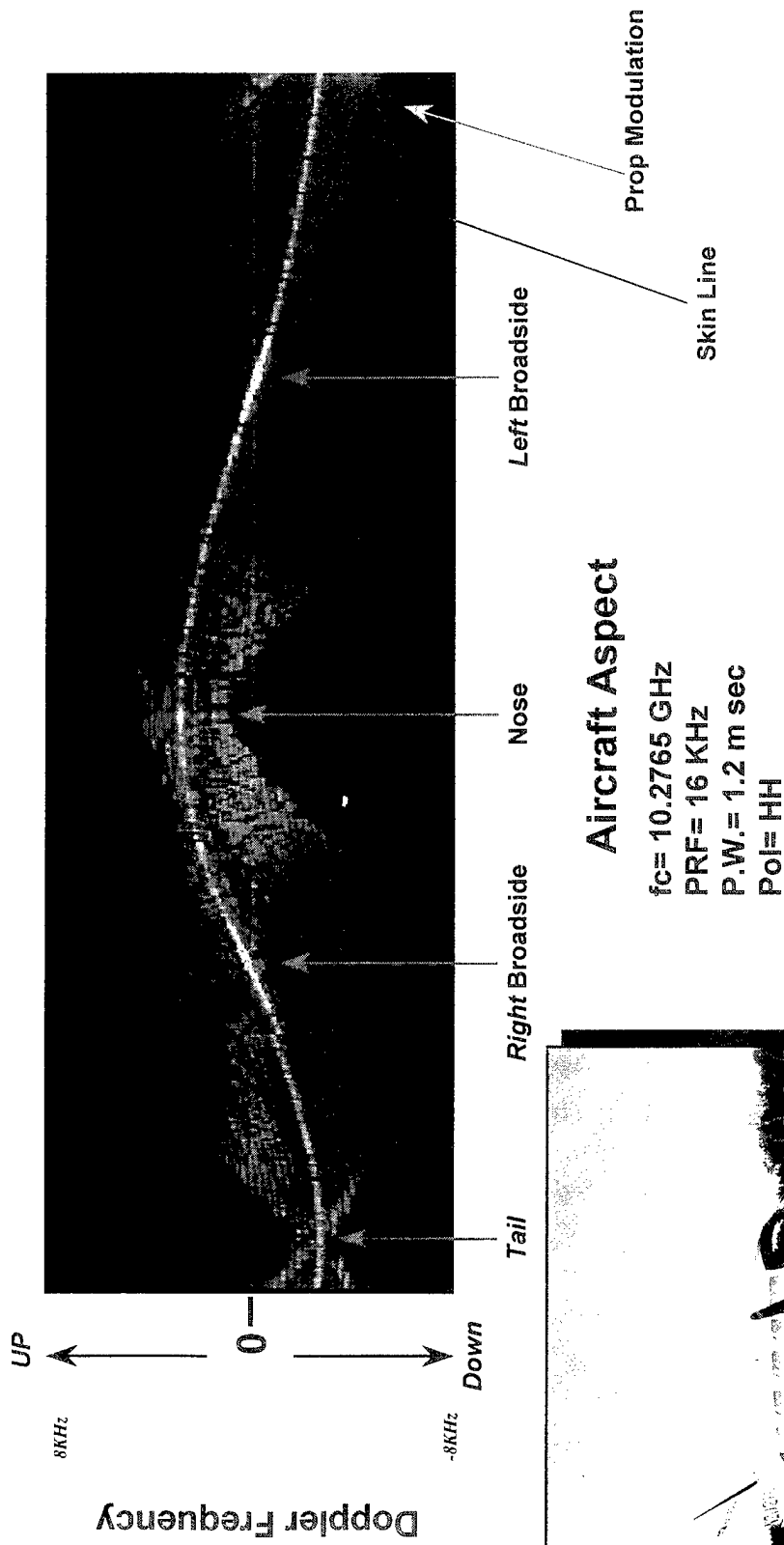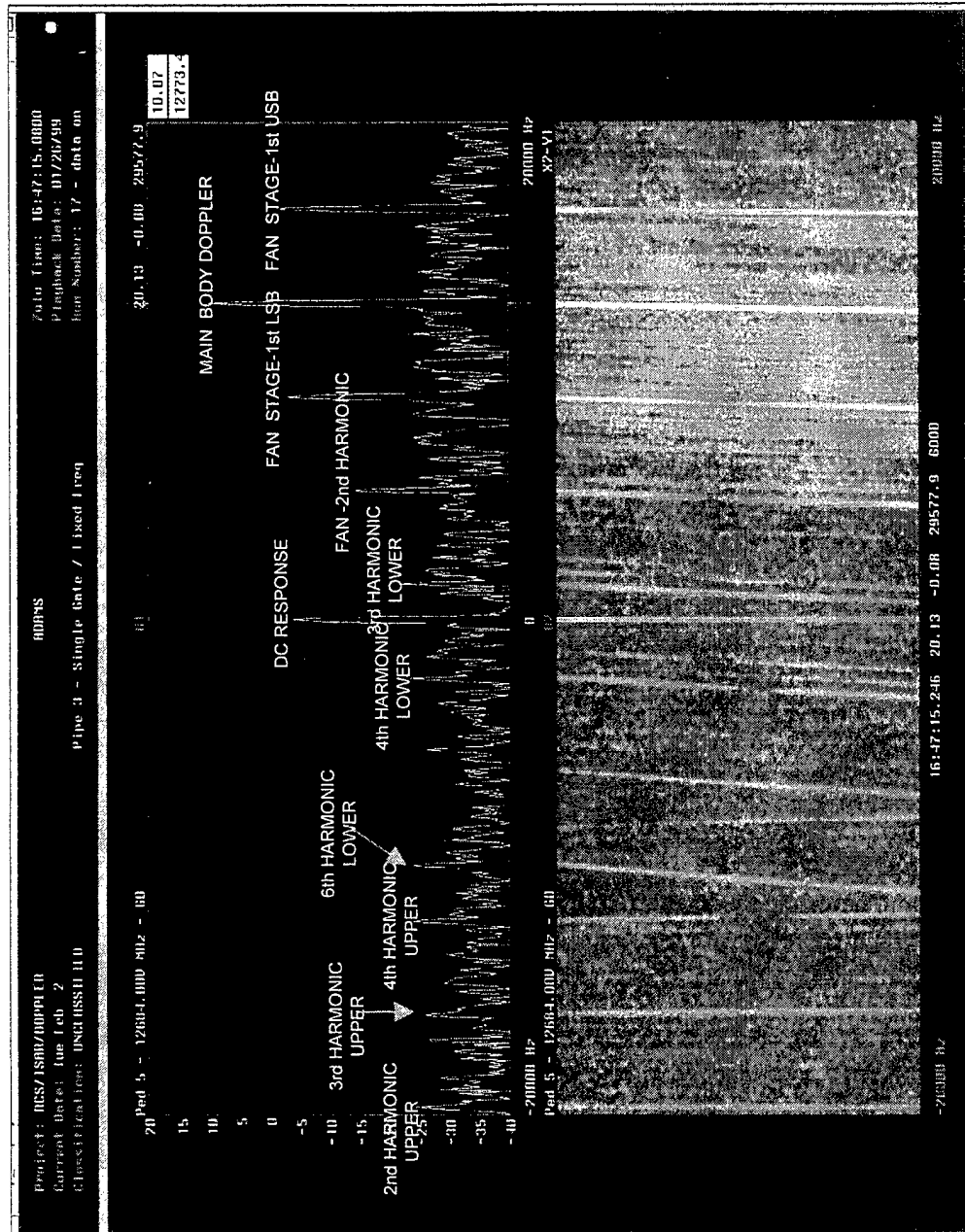
Doppler Signature Measurements Sample Data Product - JEM Spectrum/Histogram

Example: Learjet

Doppler Signature Measurements
Sample Data Product - JEM vs Aspect

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Example: Lear 36

JEM to Skin Ratio

Highest JEM line
X Band
0 deg El

JEM to Skin
(dB)
50th

JEM

Highest JEM line
X Band
0 deg El

JEM
(dBSM)
50th

Lear Jem.ppt

Different Engines = Different JEM

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Lear 36 Engine

TFE731 TURBOFAN
GARRETT ENGINE DIVISION

Allied-Signal Aerospace Company
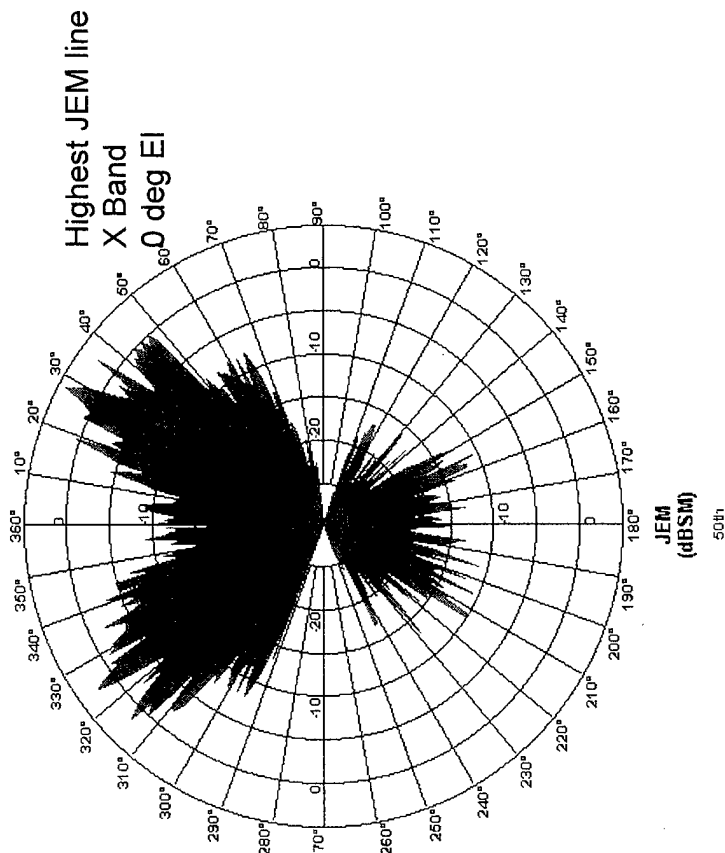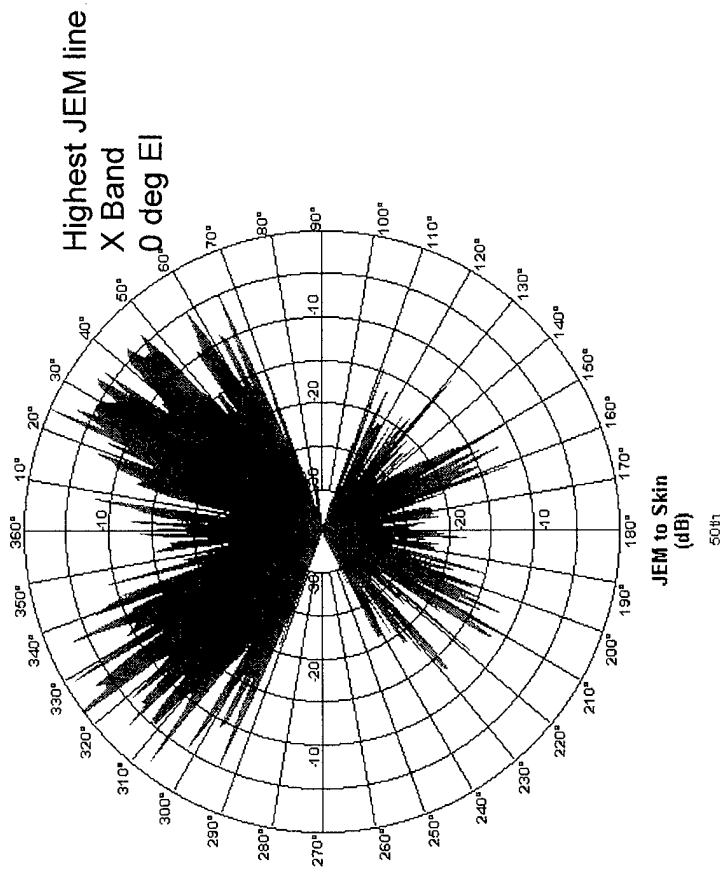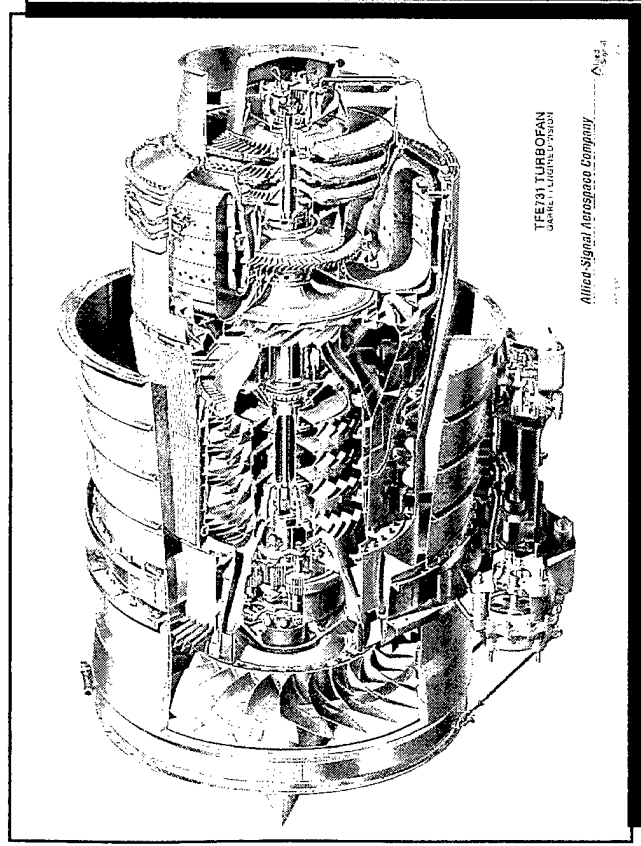
F-18E/F Engine
GE F-414
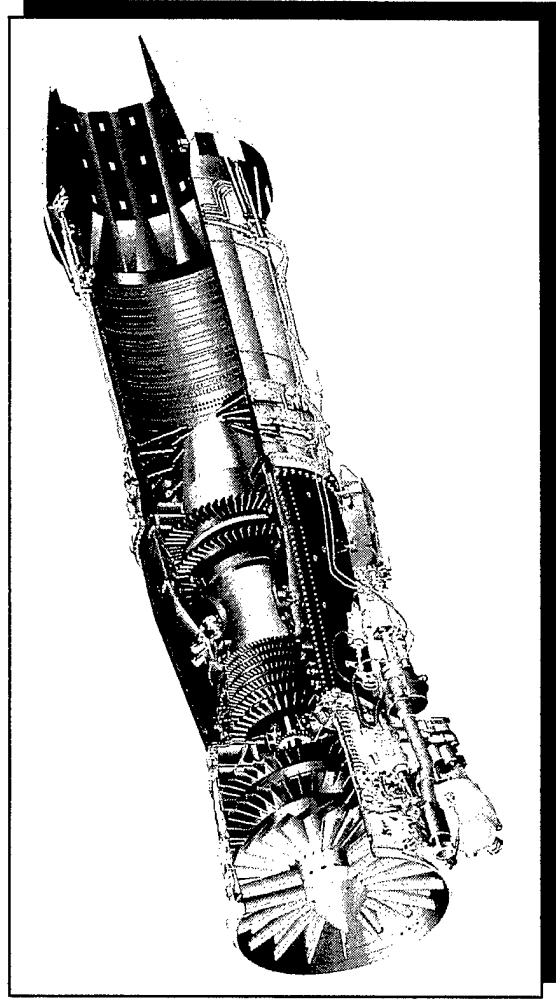
Precision Down Range Profiles

Example: Piper Navajo

Burst Number
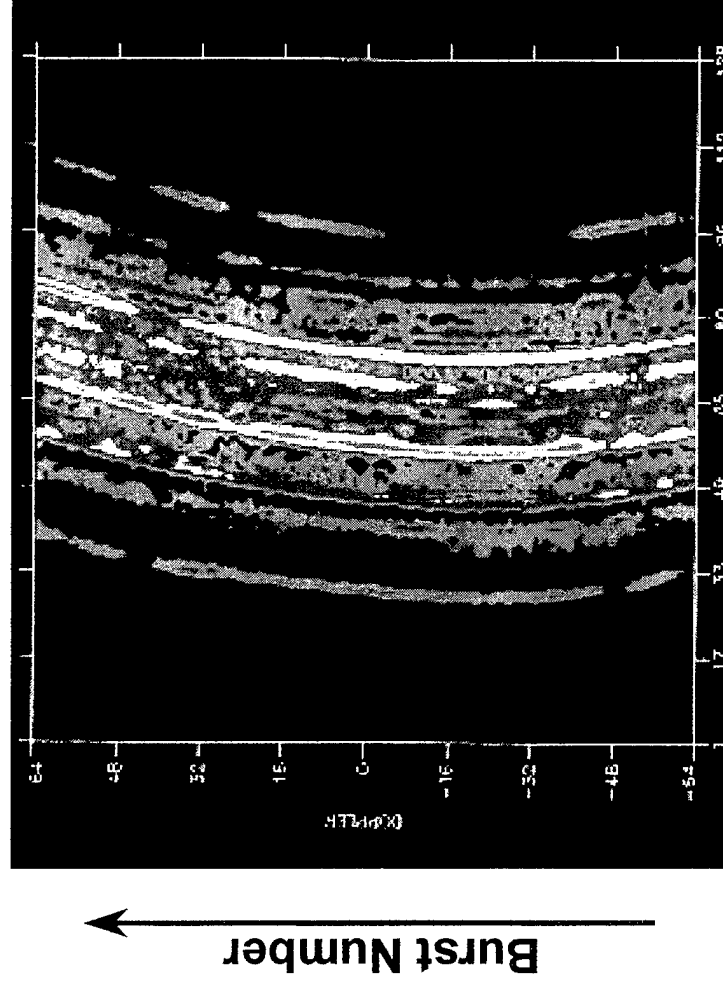
Down Range

fc= 10.2765 GHZ   Res.= 6"

PRF= 10 KHz   D f= 950 MHz

P.W.= 1.2 m sec   # steps= 128

Pol= HH

Down-Range.ppt

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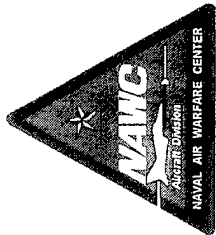
ISAR Imagery

Example: Piper Navajo

Down Range

Cross Range

Down Range

Cross Range
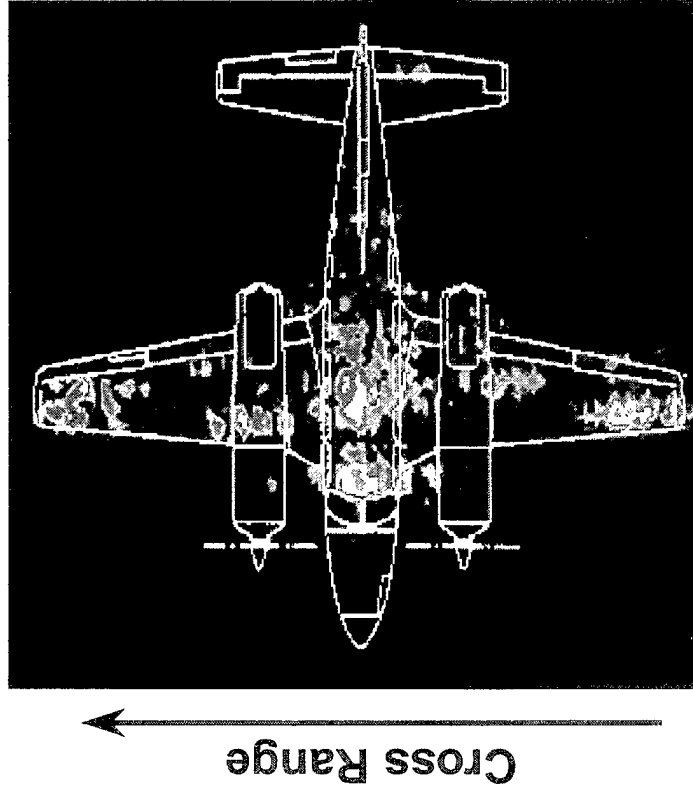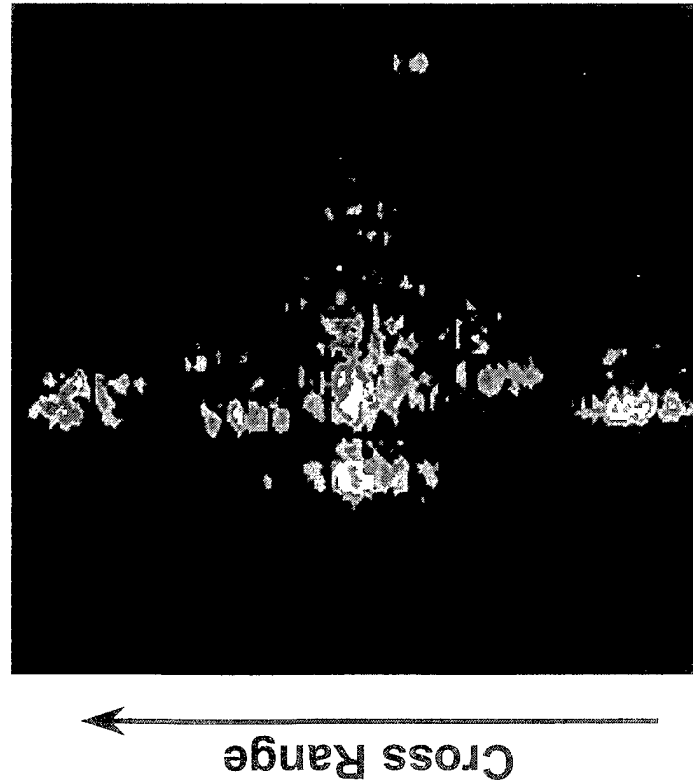
fc = 10.2765 GHZ
PRF = 10 KHz
P.W. = 1.2 m sec
Pol = HH

Res. = 6"
D f = 950 MHz
steps = 128

ISAR.ppt

Chaff Measurements
Sample Data Product - Growth Rate
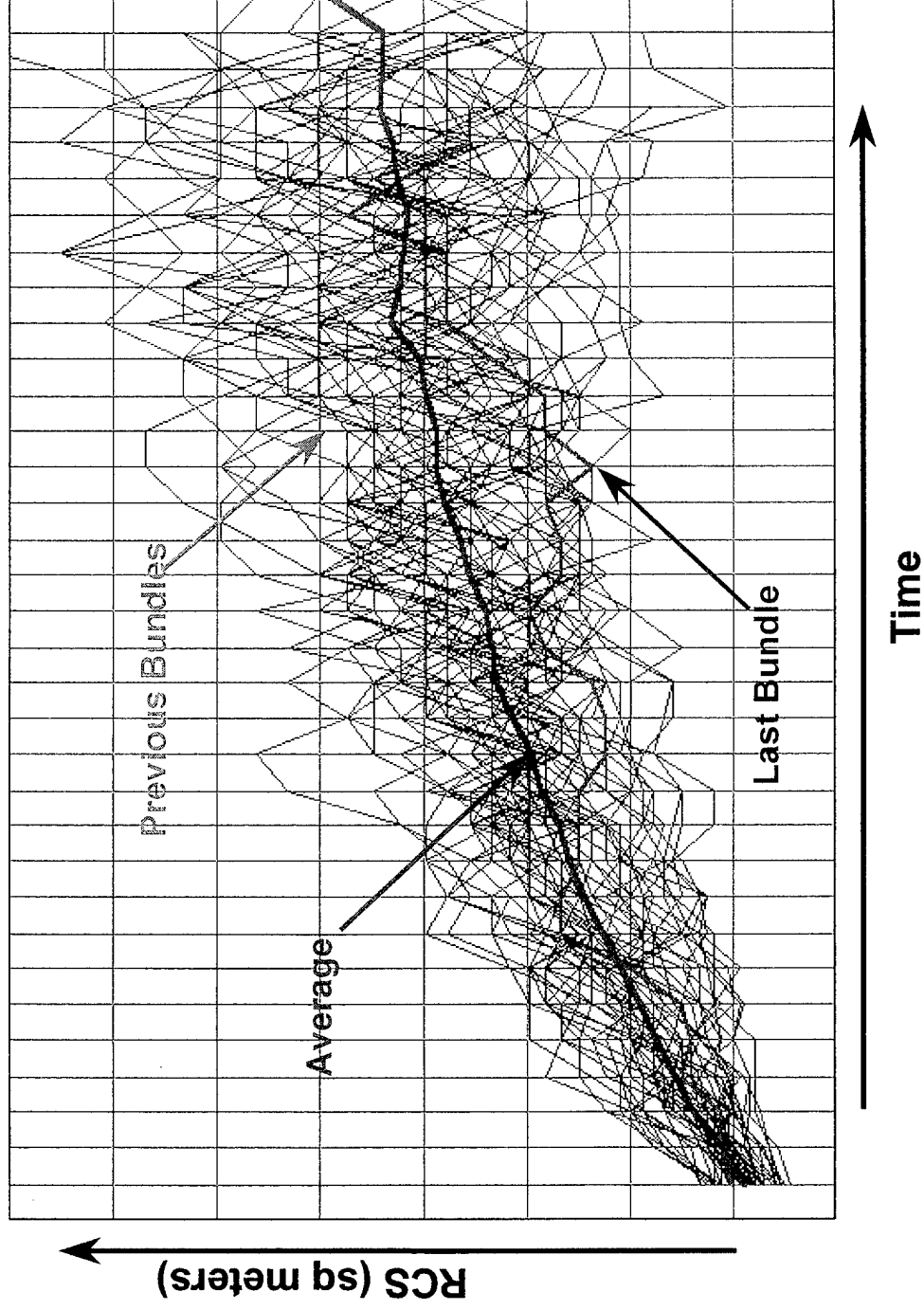
RCS (sq meters)

Time

Previous Bundles

Average

Last Bundle

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Chaff 2.ppt

Chaff Measurements
Sample Data Product - RF Spectrum

RCS VS FREQUENCY (50TH PERCENTILE)

RCS (sq meters)

Frequency (GHz)

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Chaff Measurements
Sample Data Product - Shadow Graph

Elapsed Time

Range Gates
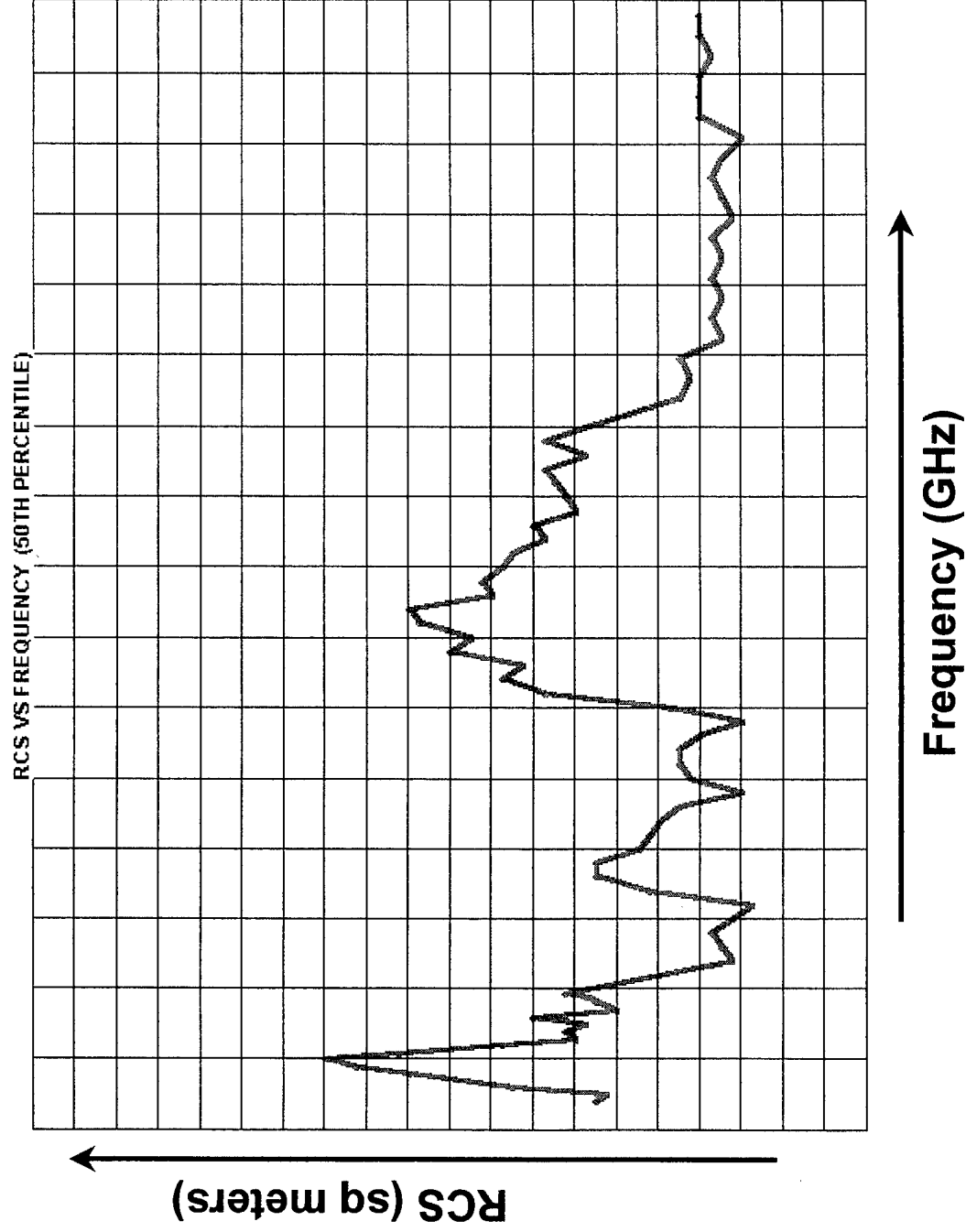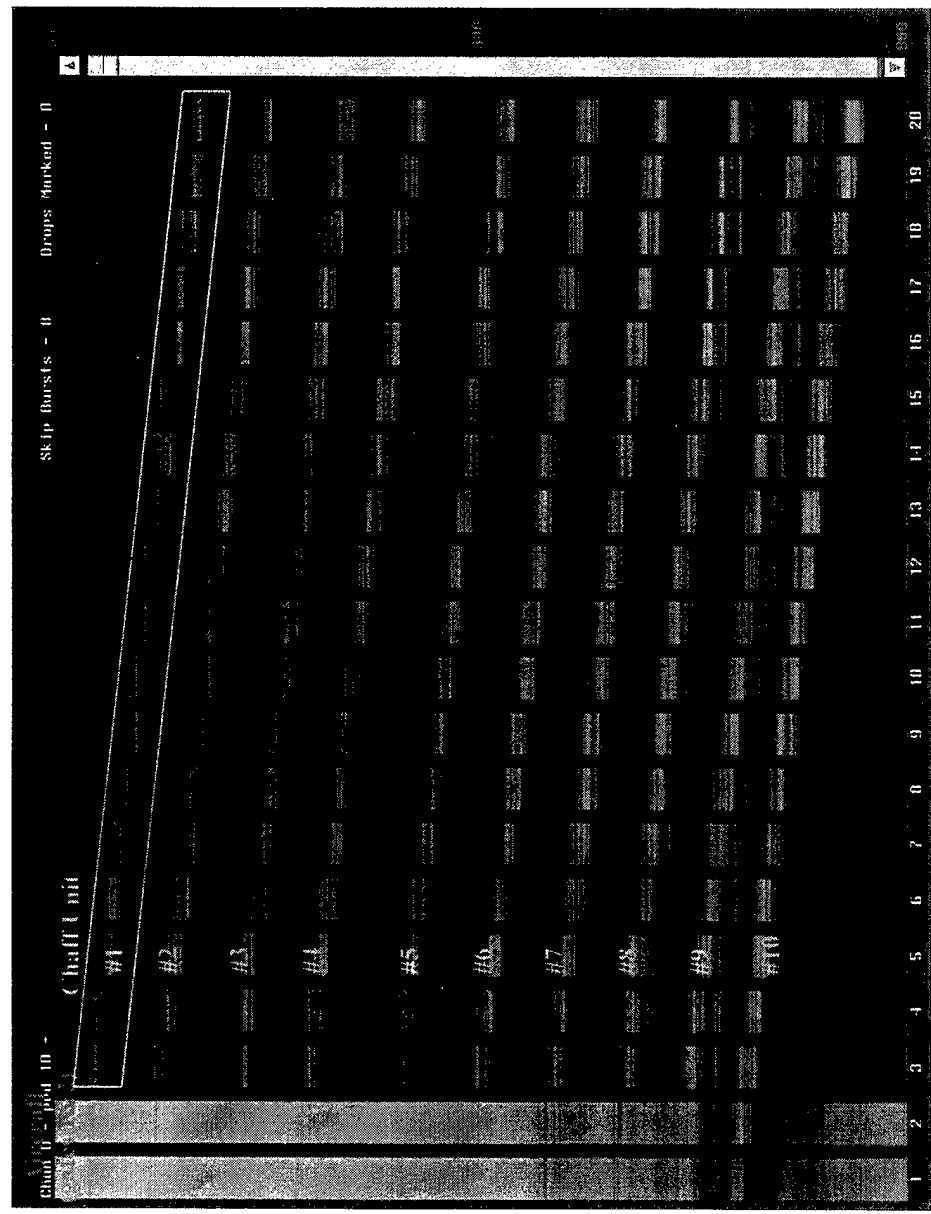
Extensive Signature Data Library

❖ Over 50 Platforms On-Line

  – Various Platform Configurations

❖ Multiple Frequencies Available

  – 150 MHz to 35 GHz

❖ Wide Elevation Coverage

  – ±45° Elevation 360° Azimuth

❖ VV and HH Polarizations

❖ Data Available to Authorized Users

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Ext Sign Data.ppt

For More Information...

Contact: Mr. Jim Tuttle/Mr. Martin Stuble

Range Measurement Team

Naval Air Warfare Center Aircraft Division

Atlantic Test Range

23029 Cedar Point Rd, Unit 4

Patuxent River, Maryland 20670-5304

(301) 342-1211 DSN: 342-1211 FAX: (301)342-1190

Email: TuttleJD @ navair.navy.mil

StubleMH @ navair.navy.mil

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